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Contents

The Performance of New Fungicides for Controlling Late Blight of Potatoes—R. S. Davidson and A. E. Rich 35

Retardation of Sprouting of Potatoes by Carbon Dioxide Storage—L. T. Kardos and P. T. Blood 39

The Influence of Sprout-inhibiting and Sprout-inducing Treatments on the Growth and Yields of Potatoes—E. A. Pujals, R. E. Nylund and F. A. Krantz 47

Sectional Notes 56

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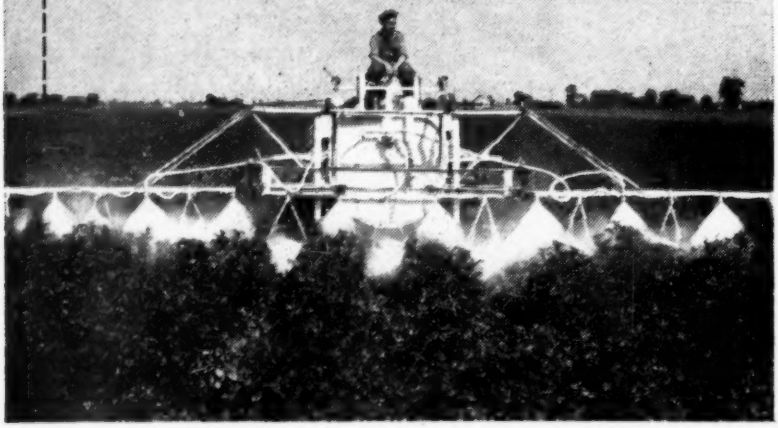

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THE PERFORMANCE OF NEW FUNGICIDES FOR CONTROLLING LATE BLIGHT ON POTATOES[1]

R. S. DAVIDSON AND A. E. RICH[2]

Rhode Island Agricultural Experiment Station, Kingston, R. I.

Bordeaux mixture is generally considered the most effective spray for controlling potato foliage diseases, especially late blight, caused by the fungus, *Phytophthora infestans*. However criticisms of Bordeaux often cited are that it causes injury to plants, is difficult to mix and is corrosive to spraying equipment. Certain organic fungicides tested in the laboratory and greenhouse lacked some of the objectionable qualities as well as exhibiting desirable fungicidal properties. The performance of these materials was compared with Bordeaux in the field on Green Mountain potatoes during the summers of 1945 and 1946. Fortunately, from the standpoint of optimum conditions for conducting such tests, blight was unusually severe both seasons. Although none of the materials tested in either 1945 or 1946 proved so effective as Bordeaux on the basis of yield, it seems desirable at this time to report the comparative action of the various spray materials tested.

1945 FIELD TRIALS

In 1945, 13 different spray materials were applied in the field as sprays to single rows of potatoes 275 feet long. Each treatment was randomized within blocks replicated 4 times. The materials and the

1. Contribution No. 694 of the Rhode Island Agricultural Experiment Station, Kingston, R. I.
2. Assistant Plant Pathologist and Assistant Agronomist, respectively.

TABLE 1.—1945 *Field trials with new fungicides.*

Treatment	Conc. per 100 Gal. H_2O	Per cent of Foliage Blighted: Average of 4 Replicates						Average Yield Bu. per Acre	Per ce. U. S. No. 1
		7/19	7/24	7/31	8/9	8/14	8/23		
Phenyl mercuritriethanol ammonium lactate (P.N-5-E)	100 ppm.	2.0	5.0	44.0	77.0	85.0	100.0	123.0*	74
Phenyl mercury formamide (P 806)	100 ppm.	1.0	4.0	30.0	76.0	87.0	100.0	88.0	65
Phenyl amino cadmium lactate (P. 177)	500 ppm.	0.5	6.0	32.0	76.0	92.0	100.0	93.0	60
Disodium ethylene bisdithiocarbamate (Dithane D-14)	2 qts.	1.0	2.0	22.0	75.0	88.0	100.0	140.0	77
Zinc dimethyl dithiocarbamate (Zerlate)	1½ lbs.	0.7	7.0	37.0	80.0	89.0	100.0	141.0	79
2, 3 dichloro 1, 4 naphthoquinone (Phygon)	2 lbs.	0.1	0.1	1.0	6.0	9.0	0.0	172.0	85
Lauryl isoquinolinium bromide (Isothan Q-15)	500 ppm.	3.0	8.0	40.0	78.0	86.0	100.0	121.0	70
Cetyl isoquinolinium bromide (Isothan Q32)	500 ppm.	0.6	6.0	20.0	72.0	80.0	100.0	130.0	74
Lauryl isoquinolinium chloride (Isothan Q90)	500 ppm.	3.0	14.0	53.0	88.0	94.0	100.0	126.0	71
Lauryl isoquinolinium thiocyanate (Isothan Q-48)	500 ppm.	4.0	12.0	50.0	85.0	97.0	100.0	118.0	69
Cetyl nicotinium thiocyanate (E.R.L. 38)	500 ppm.	3.0	14.0	53.0	88.0	94.0	100.0	113.0	69
Ferric dimethyl dithiocarbamate (Fermate)	1½ lbs.	1.0	2.0	23.0	59.0	83.0	100.0	152.0	81
Bordeaux Mixture	10-10-100	0.1	0.2	5.0	12.0	11.0	11.0	228.0	87
Control	—	4.0	22.0	61.0	87.0	93.0	100.0	118.0	68

*Difference necessary for significance at 5 per cent level ± 17 bu.: at 1 per cent ± 23 bu.
Sprays were applied on the following dates: 7/2, 7/10, 7/18, 7/23, 7/31, 8/8, 8/13, 8/22.

concentrations used are given in table 1. Eight applications of each fungicide were made at approximately weekly intervals from the 2nd of July to the 22nd of August, the sprays being applied with a single row 4-nozzle Arlington power sprayer at 300 pounds pressure, 150 gallons per acre. In addition to the fungicides, all treated and check rows received 2 applications of 5 per cent DDT micronized with Pyrax ABB, (10 pounds per 100 gallons of water) at the rate of 150 gallons per acre.

Blight was first observed on the 22nd of June. The percentage of blighted foliage was estimated for each row at six different dates during the season. These estimates are shown in table 1.

The tubers were dug on the 29th of September. The entire row of each treatment was harvested and the total weight in pounds for each replicate converted to bushels per acre. The yields of the treatments and the check plots were averaged and are given in table 1. For significance between treatments at the 5 per cent level and at the 1 per cent level, a difference in yield of 17.3 and 23.2 bushels, respectively, was necessary.

1946 Field Trials

In 1946, there were 11 treatments on 4 randomized blocks each containing 5 rows 88 feet long. All sprays were applied with a 10-row Bean power sprayer, 4 nozzles per row, at 400 pounds pressure, and at the rate of 150 gallons per acre. Nine fungicidal materials were used on the dates indicated in table 2. The plots were treated with DDT on the 7th and 20th of June and the 9th of August at the rate of 1 pound 50 per cent wettable DDT, and on the 3rd of July and the 26th with 2 pounds 50 per cent wettable DDT per 100 gallons of water. One treatment received no DDT and no fungicide, and another received DDT only.

Blight was first observed on the 11th of July. Again, the percentage of blighted foliage was estimated for the treated plots and for the controls at 4 dates during the season. The averages are shown in table 2.

The 3 middle rows in each block (approximately 0.018 acre) were harvested on the 4th of October and the yields converted into bushels per acre. The yield data were analyzed statistically and appear in table 2. For significance at the 5 per cent level and 1 per cent level,—a difference in yield of 53.4 and 71.5 bushels per acre, respectively, was necessary.

Discussion

The low yields in 1945 resulted, partially at least, from the excessive amount of vine damage caused by the wheels of the one-row

TABLE 2.—1946 *Field trials with new fungicides.*

Treatment	Conc. per 100 Gal. H_2O	Per cent of Foliage Blighted; Average of 4 Replicates				Average Yield Bu. Per Acre	Per cent U. S. No. 1
		7/24	7/31	8/9	8/21		
Control (No DDT — No Fungicide)	—	4.0	18.0	96.0	100.0	203.0*	84
Control (DDT — No Fungicide)	—	2.0	19.0	81.0	100.0	195.0	86
Bordeaux Mixture	8-4-100	0.0	0.2	1.1	4.0	404.0	93
Tribasic Copper	4 lbs.	0.0	0.2	1.5	12.5	329.0	92
2, 3 dichloro 1, 4 naphthoquinone (Phygon)	½ lb.	0.0	0.5	2.4	89.0	278.0	92
Zinc dimethyl dithiocarbamate (Zerlate)	2 lbs.	0.5	1.0	5.0	68.0	282.0	93
Lauryl isoquinolinium bromide powder (Isothan Q-15)	1 lb.	0.5	0.8	50.0	100.0	190.0	89
Lauryl isoquinolinium bromide liquid (Isothan Q-15)	1 pt.	1.2	11.0	66.0	100.0	217.0	89
Phenyl amino cadmium lactate (P. 177)	1 lb.	1.5	7.0	47.0	100.0	169.0	89
Phenol mercury acetate (P. M. A. S.)	½ pt.	0.0	6.0	27.0	99.0	196.0	87
Bis - (3, 5, 6 trichloro - 2 - hydroxy-phenyl) methane (G-11)	2 lbs.	0.2	0.7	6.0	86.0	260.0	91

*Difference necessary for significance at 5 per cent level ± 53 bu.; at 1 per cent ± 72 bu.
Sprays were applied on the following dates: 6/20, 7/3, 7/11, 7/14, 7/26, 8/9, 8/15, 8/21, 8/26.

sprayer, and from the necessity of making frequent trips through the plots with the tractor. This vine damage undoubtedly contributed to the increased amount of blight observed in comparison with adjacent plots. In 1945, only the Bordeaux-treated plots showed no perceptible increase in the amount of late blight after the last spray application. In addition to less vine damage, the more favorable growing conditions and the better insect control from more frequent applications of DDT contributed to the higher yields and larger tubers (per cent U. S. No. 1) obtained in 1946. Bordeaux and Tribasic Copper prevented a noticeable increase in the amount of late blight in 1946 after the last spray had been applied. Moreover, the plants sprayed with these materials were still partially green at digging time.

On the basis of yield, in 1945 plots treated with Bordeaux, Phygon, Fermate, Dithane and Zerlate were superior in the order given, to the plots receiving no treatment. Bordeaux was significantly better than any of the other 12 materials tested. In 1946, Bordeaux again ranked first but Zerlate, Phygon and G-11 were also significantly better than the check treatments.

In both seasons, less foliage injury was caused by the organic materials than by the sprays containing copper. The failure of some of the chemicals to control late blight was due partially to the poor adherence of the sprays to the leaves. By comparing the control which received neither fungicide nor insecticide with the control which had received only DDT, it was evident that DDT possessed no fungicidal activity, although the chemically related G-11 proved to have fair fungicidal properties.

RETARDATION OF SPROUTING OF POTATOES BY CARBON DIOXIDE STORAGE

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INTRODUCTION

Considerable interest has been shown recently in the use of hormone-like chemicals for the inhibition of sprouting of potatoes during late storage in the spring. Pioneer work at the Boyce-Thompson Institute by F. E. Denny, John D. Guthrie and N. C. Thornton, which is

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[1]Cooperative Agent, United States Dept. of Agriculture, Soil Conservation Service, Research Division.

[2]Scientific Contribution No. 110 of the New Hampshire Agricultural Experiment Station.

described in volumes 9, 10, 11 and 12 of the Contributions of the Boyce-Thompson Institute indicated the potentialities of the hormone method for sprout retardation and its application was tested in Wisconsin, by Thomas and Riker (7); in New Jersey, by Daines and Campbell (2); and in New York by Ora Smith (6).

Studies of the influence of carbon dioxide (CO_2) on storage of fruits and vegetables have been numerous and among them several cite experiments on the influence of CO_2 on sprouting. Kidd (5) using *non-dormant* potatoes found that 10 per cent CO_2 retarded growth of buds somewhat and 20 per cent CO_2 inhibited growth of the buds. Braun (1), using both dormant and non-dormant tubers, found that sprouting was stimulated by CO_2 over a range of from 2.44 per cent to 20.2 per cent CO_2. Experiments with *dormant* potatoes which were directed primarily at causing sprouting indicated that low oxygen tension tended to stimulate sprouting and at normal oxygen tensions increasing CO_2 beyond 20 per cent CO_2 tended to decrease sprouting (8,9).

These latter studies were carried out at or near room temperatures. Thornton (10) noted, during studies on the influence of CO_2 on oxygen uptake by non-dormant sprouting tubers at 25°C. that the higher concentrations (35, 40 and 60 per cent) of CO_2 did retard the growth of the sprouts and caused some blackening of the tips of the sprouts.

Other studies (11,3) on sugar-starch transformations indicated that at room temperatures an increase in CO_2 concentration to 30 or 60 per cent increased sugaring, whereas at low temperatures (2° - 5°C.) the rapid sugaring which usually takes place at these temperatures may be inhibited by as little as 5 per cent CO_2 and that the inhibition persisted for as long as 90 days.

The marked difference in behavior of potatoes in the presence of CO_2 at one temperature as compared with another, the tendency for CO_2 to be associated with sprout behavior and the contradictory information on the effect of CO_2 on sprout retardation at normal late spring storage temperatures (50° - 55° F.) led to the investigation described below.

Experimental Procedure and Results

In the spring of 1945, on the 11th of April, non-dormant, Green Mountain, B-size, sound tubers were selected from a pile and placed in each of four wooden barrels. Each barrel was fitted with a gas inlet and an outlet tube to control the flow of gas and degree of aeration, with a sampling tube to permit extraction of a sample of the gases

within the barrel and with a thermocouple for indicating temperature within the barrel. Each barrel was also fitted with a window which permitted examination of the contents without breaking the seal. The barrels were of such a capacity that they contained approximately eighty-five pounds of tubers. After sealing the barrels the following gaseous conditions were impressed upon them:

I. Carbon dioxide gas was passed into the barrel from a compressed gas cylinder and air allowed to diffuse into the barrel in sufficient quantities to maintain approximately a mixture of 12 per cent CO_2 by volume with the oxygen and nitrogen being displaced proportionately.

II. Carbon dioxide concentration of approximately 12 per cent developed and maintained by respiration of the tubers themselves and with sufficient aeration to prevent building up the CO_2 content beyond this value.

III. Carbon dioxide concentration of approximately 11 per cent built up by injection of CO_2 from compressed gas cylinder and then

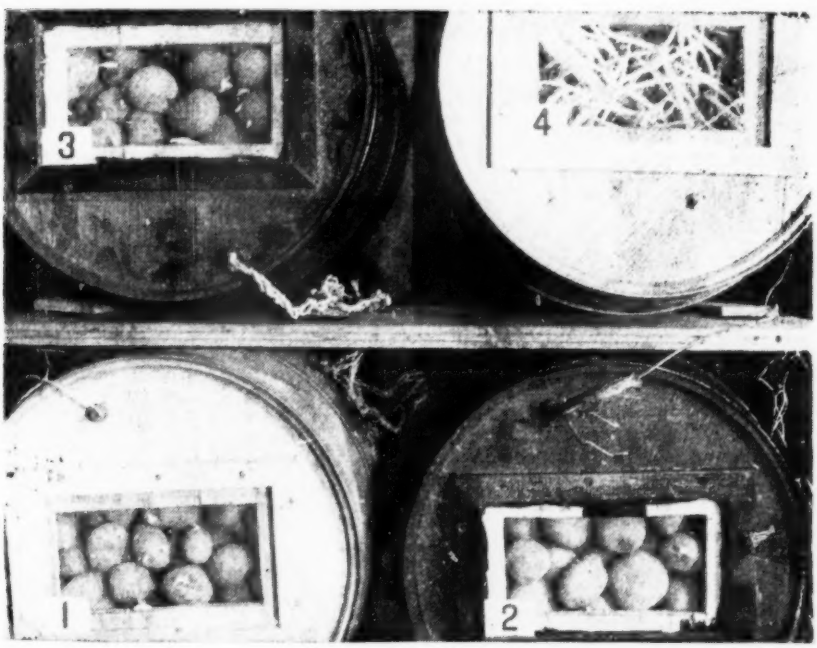

FIGURE 1. Degree of sprouting on June 8, 1945 when storage temperature had reached a value of 55° F.

Numbers 1, 2, 3, 4 refer respectively to treatments I, II, III, IV.

Note how sprouts have completely filled the window area in the check treatment (No. 4) whereas the CO_2 treatments, 1, 2 and 3 have sprouted very little.

maintained by respiration of the tubers together with slight aeration but with occasional further injections of CO_2.

IV. Carbon dioxide concentration of less than 1 per cent developed by respiration of the tubers in a barrel perforated with holes to permit fairly complete aeration.

The barrels were exposed to the prevailing storage room temperatures which ranged from 42°F. in April to 66° F. in July. The temperature within the barrels was, in general, at or very slightly above the temperature of the storage room.

Carbon dioxide was determined daily and oxygen only intermittently using an Orsat gas analyzer. Temperatures within the barrel were determined by means of a Leeds and Northrup potentiometer and the storage room temperatures from a mercurial thermometer.

The progress of the sprouting was observed through the windows of the barrels and a photograph taken on June 8 (Fig. 1). The temperatures in the barrels ranged from 50° to 55° F. between the 9th of May and the 8th of June and from 55° to 66° F. between the 9th of June and the 7th of July.

At the close of the experiment on the 9th of July the barrels were opened and the weights of sprouts determined. (Table 1) As indicated in the table, the check treatment, No. I, had a weight of sprouts which was 5 to 25 times as great as the various CO_2 treatments. The tubers from treatments I, II and III were smooth and firm and had short, stubby sprouts, whereas those from treatment IV were flabby and wrinkled and had long, vigorously growing sprouts.

TABLE 1.—*Preliminary experiment on CO_2 retardation of sprouting Green Mountain variety ** April 11 to July 9, 1945.*

(Initial weight of tubers approximately 85 pounds)

Treatment Number	Average Per cent CO_2	Sprout Weight Lbs.
I	12.5	0.33
II	11.8	0.30
III	11.2	1.58
IV	0.6	8.25

Random samples taken from the respective barrels were cooked and eaten to determine whether quality and flavor had deteriorated. Those from the barrels with restricted aeration (II and III) had a musty odor and flavor but were fairly mealy. Those from the more thoroughly aerated barrels (I and IV) had no off flavor or odor but

TABLE 2.—*Carbon dioxide retardation of sprouting—Katahdin variety—March 18 to May 6, 1946.*

	Treatment	Average		Tubers + Sprouts (pounds)			Sprouts		Total Loss Per cent	Specific Gravity*
		Per cent CO_2	Per cent O_2	Original Weight	Final Weight	Per cent Loss	Grams	Per cent Original Weight		
I	Check	0.9	19.5	83.3	81.5	2.16	1677	4.44	6.60	1.0775
II	CO_2 supplied wholly by respiration	7.8	13.1	83.2	81.9	1.56	737	1.96	3.52	1.0768
III	CO_2 supplied from compressed gas cylinder with continuous flow	10.5	13.6	85.1	83.9	1.41	68	0.18	1.59	1.0780
IV		7.6	17.0	85.0	83.4	1.88	472	1.23	3.11	1.0779

*Average of 50 tubers.

those from treatment IV were somewhat soggy in texture while those from treatment I were fairly mealy.

The source of the off flavor and odor in II and III was thought to be the rotting tubers which were present in all four barrels. In barrels II and III these rot emanations accumulated, whereas in barrels I and IV they did not.

In 1946, further experiments were carried out using CO_2 gas as a sprout retardant and the gaseous method was compared with the hormone method using the methyl ester of alpha-naphthaleneacetic acid.*

Approximately 85 pounds of Katahdin potatoes, selected for freedom from bruises or other mechanical injury and grading as U. S. No. 1 were placed in the same wooden barrels which were used previously. The barrels were fitted as described above, sealed, and then placed into a specially constructed constant temperature box. The latter was heated with a greenhouse bed heating cable which was strung around the walls and maintained at a temperature of 52° ± 1° F. by means of a thermostatic switch.

Varying degrees of aeration and carbon dioxide concentration were then imposed on the potatoes in the respective barrels, shown in table 2.

At the same time, in order to compare the carbon dioxide method with a chemical method of retarding sprouting, a peck of Katahdin potatoes was placed in each of three heavy paper bags and the potatoes in two of the bags treated with 0.9 grams and 0.45 grams of methyl ester of alpha-naphthalene acetic acid per bushel of potatoes. The methyl ester was applied in the form of a Pyrax talc dust containing 0.4 per cent of the methyl ester. The third bag was left undusted. All three bags were then tied securely with twine and placed in the constant temperature box.

After 49 days in the constant temperature box the degree of sprouting was determined and is shown in the following photographs and tables. Figs. 2, 3 and tables 2, 3.

The data indicated that treatment III with an average CO_2 content of 10.5 per cent and an average of O_2 content of 13.6 per cent was most effective in retarding sprouting and was fully as effective as the hormone treatment in this regard.

The second best gaseous treatment was No. IV with an average of 7.6 per cent CO_2 and approximately 17 per cent. O_2. The shrinkage of the tubers in treatment IV was greater than in treatment II but the sprouting was sufficiently less to make the total loss somewhat smaller than in treatment II.

*Obtained through the courtesy of Merck and Co., Inc., Rahway, N. J.

FIGURE 2. 1946 Experiment — CO_2 Retardation of Sprouting. Degree of sprouting on May 7, 1946 after storage at 53° ± 1° F. for 49 days. No. 1—check; No. 2—7.8 per cent CO_2 supplied by respiration alone; No. 3—10.5 per cent CO_2 and No. 4—7.6 per cent CO_2, both supplied primarily by CO_2 from compressed gas cylinder. Sprouts taken from approximately 85 pounds of tubers.

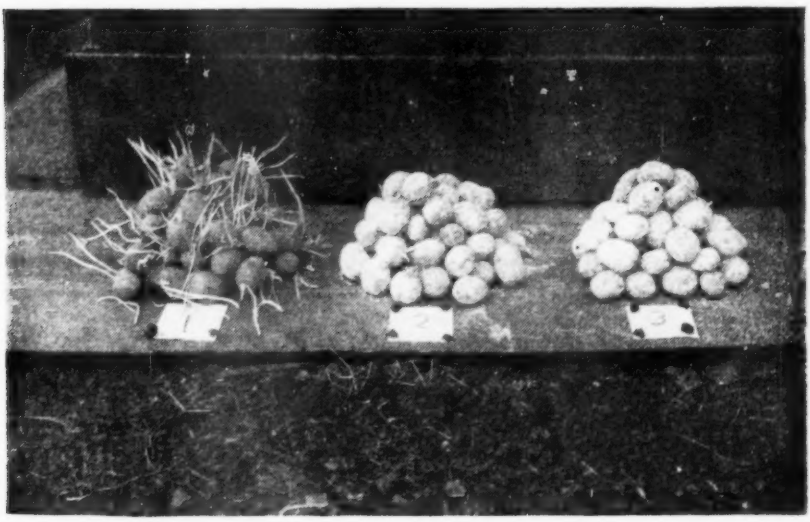

FIGURE 3. Methyl Ester Hormone Retardation of Sprouting—after storage at 53° ± 1° F. for 49 days. No. 1—check; No. 2—0.45 grams hormone per bu.; and No. 3—0.90 grams hormone per bu.

The degree of sprouting of the check treatments in the barrels and in the peck bag were almost identical and approximately 25 times as great as the best gaseous treatment and 20 times as great as the best methyl ester treatment.

TABLE 3.—*Hormone retardation of sprouting.*

Treatment	Hormone Concentration Grams Bu.	Sprouts Per cent of Original Wt.
A	0.0	4.58
B	0.45	0.63
C	0.90	0.22

Both of the methyl ester treatments were more effective in retarding sprouting than the CO_2 treatments which had less than 8 per cent CO_2. The results during 1945 and 1946 indicated that a highly effective CO_2 concentration lay in the range of 10 to 12 per cent CO_2 and that short periods of several days with concentrations down to 8 per cent CO_2 or up to 14 per cent CO_2 did not seriously alter the effectiveness of the treatment.

Cooking tests of random samples from the various barrels showed no off-flavors and the various tubers were equally mealy in texture. No rotted tubers were found in any of the barrels hence it is indicated that the method of gaseous storage when used with sound tubers does not induce rotting or death of the tubers.

The sprout retarding action of the CO_2 treatment persists to a moderate degree after removal of the tubers to normal atmospheric conditions and further study of the effect of this persistence will be necessary before its use with seed stock can be recommended.

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THE INFLUENCE OF SPROUT-INHIBITING AND SPROUT-INDUCING TREATMENTS ON THE GROWTH AND YIELDS OF POTATOES[1]

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INTRODUCTION

Excessive sprouting of stored potatoes intended for use as seed occurs in the potato region southeast of Buenos Aires, Argentina. This region has a seven month period between growing seasons, extending through fall, winter and spring in which temperatures are moderate. These moderate temperatures make it difficult to keep tubers dormant after the end of the rest period.

The recommended practice in this region has been to allow tubers to remain in the field until they begin to sprout. The tubers are then stored in piles above ground and covered with straw. The temperatures during mid-winter tend to restrict further sprouting. This is followed by a relatively long period of moderate weather with occasional frosts in late winter and early spring. During this period potatoes sprout excessively, resulting in decay and shrinkage. The present study, conducted during the winter of 1944-1945, was made to determine if seed potatoes could be treated chemically to inhibit sprouting under storage conditions similar to those described above and subsequently treated with another chemical to promote sprouting and growth at planting time.

REVIEW OF LITERATURE

The literature on dormancy in potatoes has been reviewed by Rosa (12) and Smith (13). The earlier work on the use of plant

[1]Paper No. 2316 of Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minnesota.

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[3]Assistant Professor in Horticulture.

[4]Professor of Horticulture.

hormones to inhibit growth of buds of various plants has been reviewed by Went and Thimann (15).

In relation to potatoes, Elmer (8) observed that sprouting was inhibited by the presence of ripening apples which, among other things, released ethylene gas into the atmosphere. Experiments on the use of chemicals for the prevention of sprouting in potato tubers were first reported by Guthrie (9), (10), (11) and Denny, Guthrie, and Thornton (5). Thomas and Riker (14) found that chemical treatments were effective on all potato varieties tested, including Chippewa, Cobbler, Red Warba, Russet Burbank, Russet Rural and Triumph.

The hastening of sprouting of dormant tubers was studied by Appleman (1) who stimulated growth of sprouts by removing the periderm around the eyes and by mechanically injuring the tissue surrounding the eyes. He also employed several chemicals to break the rest period and reported the most satisfactory results with ethyl bromide. After Denny (2), (3), (4), published his experiments on the use of chemicals in hastening the sprouting of potato tubers, the literature on this phase has become very extensive. The practical applications of this mass of information have been condensed by Denny in a recent paper (7).

Studies pertinent to the work reported in this paper were made by Denny (6). He presents results on germination in the spring of tubers treated over winter with methyl ester of alpha naphthaleneacetic acid, with and without chemical treatments to break dormancy. Denny states the results of his experiment as follows: "Tubers removed from the treatment bins in March to May, 1942, cut into pieces and planted in soil, germinated poorly, especially in the lots treated with methyl ester at a rate of 100 milligrams per kilogram, and with less than 50 per cent of germination with lots treated with 33 milligrams per kilogram. Washing the treated tubers with soap and water favored germination. Treatments with ethylene chlorhydrin or combinations of treatments with ethylene chlorhydrin and sodium thiocyanate or thirourea brought about further improvement in germination. However, even then, complete germination of sprouts was not obtained. It is believed that the sprout dormancy induced by the vapor of methyl ester of naphthalene acetic acid is more pronounced than that which occurs in the natural rest period of the tubers of this variety of potatoes."

Materials and Methods

The general procedure was to maintain dormancy by what seemed to be the most effective chemical treatment reported. Then after three months of storage to break the dormancy with the well-known ethylene

chlorhydrin treatment, plant the tubers in the field and record the germination, vine growth, and yield.

The experiment was a factorial involving the following treatments:

1. Two varieties: Triumph and Cobbler.
2. Three treatments to prevent sprouting:
   A. Dusting with methyl ester of alphanaphthaleneacetic acid at a rate of 20 milligrams per kilogram of potatoes. The methyl ester diluted with acetone was mixed with talc at the rate of 20 milligrams of the methyl ester to 1.65 grams of talc. After the mixture was dry it was ground in a mortar to a fine dust. This will hereafter be referred to as the "dusted" treatment.
   B. Spraying tubers with Fruitone 46, a commercial preparation consisting of an alcohol solution of ethyl naphthyl acetate, so as to wet them thoroughly. This treatment will hereafter be referred to as the "sprayed" treatment.
   C. No chemical treatment. This will be referred to as the "check" treatment.
3. The potato samples were stored at two temperatures:
   A. 68° - 82° F.
   B. 50° - 55° F.

All treatments were made in duplicate using eight-pound lots of tubers placed in tin containers.

The chemicals were applied on the 17th of January. Tubers were examined at 7 to 9-day intervals to determine the per cent of sprouted tubers. On the 1st of May, one kilogram of potatoes from each sample was desprouted and the weight of the sprouts recorded.

On the 26th of April, in order to break the dormancy, all samples of one replicate were treated with 40 per cent ethylene chlorhydrin solution at the rate of 1.3 cc. per cubic decimeter of the container for 24 hours. On the 28th of April samples from all lots were planted in the field in a split-plot arrangement. The main plots were set aside for varieties; these were divided for temperature and then subdivided for the six different treatments. The emergence was recorded at weekly intervals from time of planting. In mid-season the number of stems per seed piece, and at harvest the yield per plant, was recorded.

Results of Treatments to Prevent Sprouting

The effects of the dormancy treatments and storage temperatures on the development of sprouts on the varieties Triumph and Cobbler are shown in table 1. Figures 1 and 2 show the appearance of samples of tubers of Triumph and Cobbler, respectively, 98 days after treatment.

TABLE 1.—*Percentages of tubers sprouted on indicated dates after having been treated on January 17 with*: (1) *talc (check)*, (2) *Fruitone #46 (sprayed)*, *or* (3) *methyl ester of naphthaleneacetic acid (dusted)*.

Dormancy Treatment	Storage Temperature	Total Per cent Tubers Sprouted on Indicated Dates: 1/25	2/1	2/8	2/15	2/23	3/1	3/9	3/19	3/29	4/7	4/16	4/26	Wt. of Sprouts from 1 Kg. of Pot. on 5/1
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Mgms.
		Variety: Triumph												
1. Check	68-82° F.	10.4	75.3	100.0										77
	50-55° F.	0.0	4.4	6.6	16.2	34.8	53.7	90.6	100.0					42
2. Sprayed	68-82° F.	2.3	37.0	67.7	75.7	82.6	88.6	100.0						52
	50-55° F.	0.0	2.9	2.9	14.0	22.4	32.4	70.8	74.3	86.3	100.0			41
3. Dusted	68-82° F.	1.0	1.0	3.8	12.4	12.4	12.4	16.6	37.6	39.6	41.5	42.4	44.2	Too small to
	50-55° F.	0.0	2.9	2.9	6.8	8.4	9.8	23.2	30.2	47.8	58.4	68.6	70.4	be desprouted
		Variety: Cobbler												
1. Check	68-82° F.	22.7	95.8	100.0										84
	50-55° F.	3.1	23.4	23.4	63.8	73.3	80.3	100.0						20
2. Sprayed	68-82° F.	16.0	63.1	91.3	94.8	97.4	100.0							59
	50-55° F.	0.0	8.0	8.0	10.2	14.1	20.2	46.4	61.9	71.7	80.8	100.0		5
3. Dusted	68-82° F.	12.4	18.6	30.0	30.0	30.0	31.3	41.2	48.0	48.0	48.0	48.0	50.4	Too small to
	50-55° F.	0.0	21.5	22.8	32.2	35.0	38.8	63.6	72.4	80.2	80.2	100.0		be desprouted

With both varieties the "dusted" treatment was more effective in inhibiting sprouting than was the "sprayed" treatment. The data in table 1 also show that, with both varieties the "dusted" treatment was more effective at the high temperature storage (68 - 82° F.) than at the low temperature storage (50 - 55° F.). This was probably due to more rapid and more complete vaporization of the naphthaleneacetic acid ester at the higher temperatures.

The weights of sprouts removed from one kilogram samples of all lots of dusted potatoes 99 days after treatment were too minute to be easily measured. "Sprayed" potatoes in the same period of time produced almost as much sprout growth as did the untreated potatoes.

Results of Treatments to Induce Sprouting

On the 26th of April, 99 days after sprout-inhibition treatments had been applied, all samples of one replicate were treated with 40 per cent ethylene chlorhydrin to hasten sprouting. On the 28th of April, tubers from all treatments were planted in the field in order to observe the effect of the various treatments on rate of emergence, stand, number of stems, and yield.

Plant Emergence:

Plants began to emerge from the soil on the 23rd of May,—25 days after planting. Figure 3 diagrammatically shows the number of emerged plants at intervals from the 23rd of May to the 23rd of June as an average of the two varieties grown in the test.

The emergence of the unsprayed, undusted potatoes was most rapid. Treating such tubers with ethylene chlorhydrin delayed emergence slightly.

Those tubers which had been sprayed or dusted with sprout-inhibiting materials were the slowest to emerge. However, treating such tubers with ethylene chlorhydrin hastened emergence and also significantly increased the final stand from 77.3 per cent to 94.7 per cent for the "sprayed" tubers and from 74.7 per cent to 97.3 per cent for the "dusted" tubers.

As is apparent from figure 3, tubers having chemically induced dormancy can give as good a stand when planted as untreated seed tubers provided the former are chemically treated to induce sprouting before being planted. However, it took approximately 20 days longer for the "sprayed" or "dusted" tubers to produce a maximum of plants than did the untreated tubers. As will be discussed below, this delay in emergence is reflected in final yield of tubers.

Number of Stems (Plants) per Seed Piece:

The average number of stems per seed piece for each treatment are given in table 2. Tubers which had been sprayed or dusted to in-

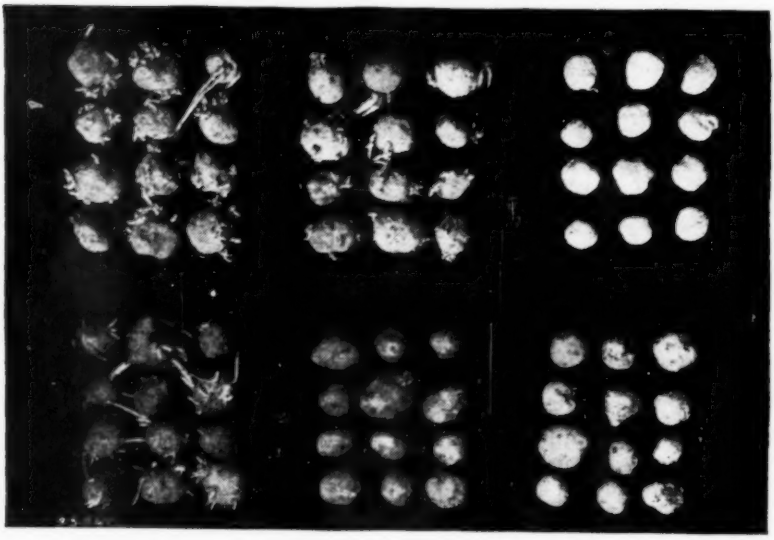

FIGURE 1.—Triumph potatoes on April 25, 1945. 98 days after application of treatments to inhibit sprouting. Upper groups: tubers stored at 68-82 F.; lower groups: tubers stored at 50-55 F. Left: untreated tubers; center: tubers sprayed with Fruitone 46; right: tubers dusted with methyl ester of naphthaleneacetic acid.

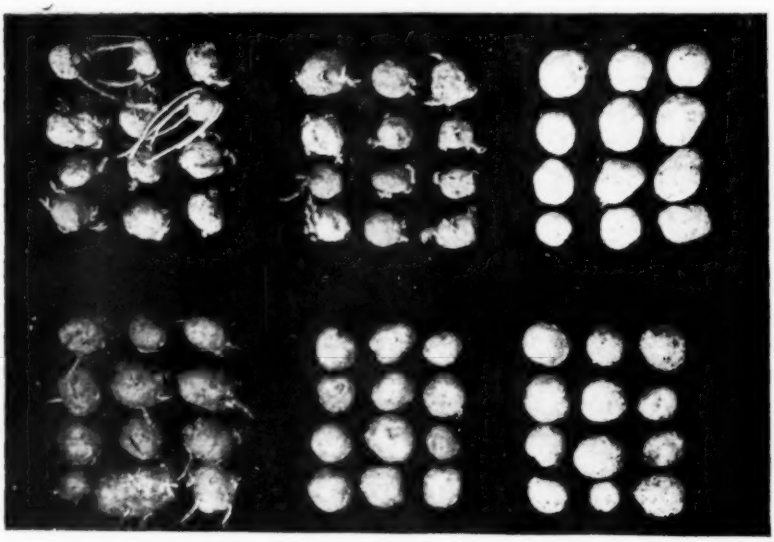

FIGURE 2.—Cobbler potatoes on April 25, 1945. 98 days after application of treatments to inhibit spriuting. Upper groups: tubers stored at 62-82 F.; lower groups: tubers stored at 50-55 F. Left: untreated tubers; center; tubers sprayed with Fruitone 46; right: tubers dusted with methyl ester of naphthaleneacetic acid.

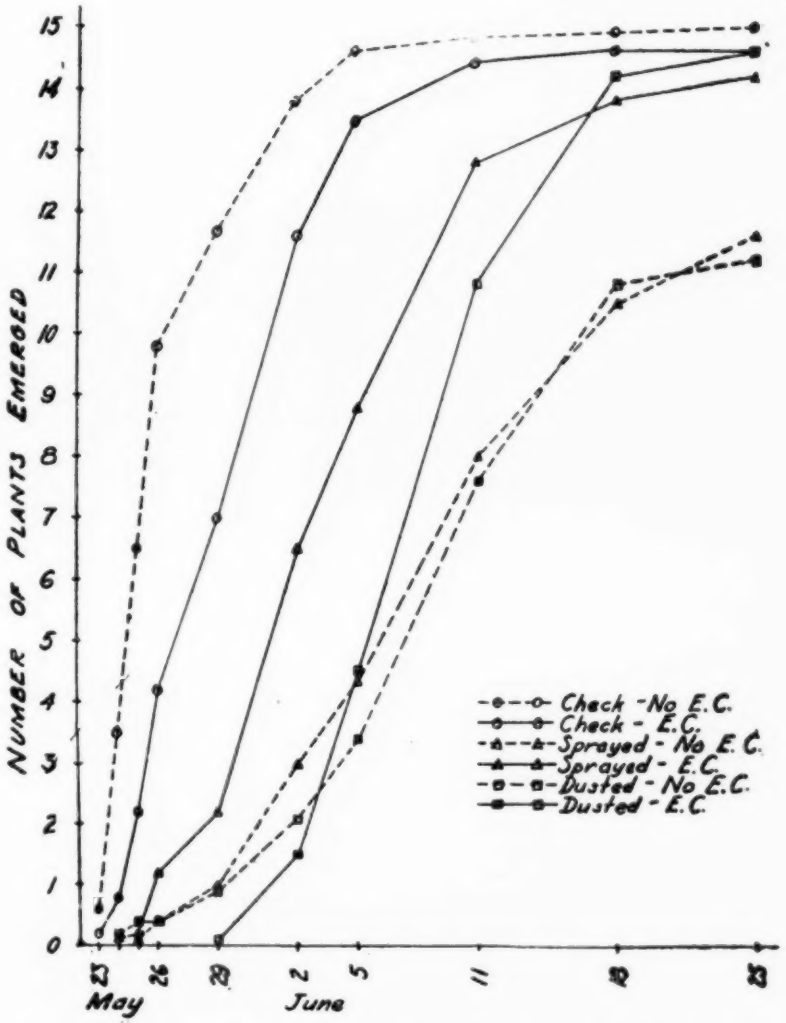

FIGURE 3.—Emergence of plants from planted seed pieces of tubers which had received: (1) no treatment (check), (2) Fruitone 46 (sprayed), or (3) methyl ester of napthaleneacetic acid (dusted) to inhibit sprouting followed by treatment with ethylene chlorhydrin (E.C.) or no ethylene chlorhydrin (no E.C.) to induce sprouting.

hibit sprouting produced significantly fewer stems when planted than did untreated tubers. Tubers treated with ethylene chlorhydrin to induce sprouting produced a significantly larger number of stems than did tubers not treated with ethylene chlorhydrin regardless of previous treatment.

TABLE 2.—*Numbers of stems per seed piece after indicated sprout-inhibiting and sprout-inducing treatment.*

Dormancy Treatment	Numbers of Stems in Indicated Classes: Treated with Ethylene Chlorhydrin	Not Treated with Ethylene Chlorhydrin	Mean	Diff. Nec. for Odds of 19:1
	(Number)	(Number)	(Number)	
Check	6.1	4.4	5.2	0.8
Sprayed	3.7	1.6	2.7	0.8
Dusted	2.5	1.7	2.1	0.8
Mean	4.1	2.6		0.4
Difference necessary for odds of 19:1	0.8	0.8	0.5	

Yield of Tubers:

The average yields in pounds per hill obtained with different combinations of treatments are given in table 3.

TABLE 3.—*Yields per hill from seed tubers after indicated sprout-inhibiting and sprout-inducing treatments.*

Dormancy Treatment	Treated with Ethylene Chlorhydrin	Not Treated with Ethylene Chlorhydrin	Mean	Diff Nec. for Odds of 19:1
	(Pounds)	(Pounds)	(Pounds)	
Check	1.48	1.32	1.40	0.32
Sprayed	1.26	0.87	1.06	0.32
Dusted	0.95	0.91	0.93	0.32
Mean	1.22	1.03		0.18
Difference necessary for odds of 19:1	0.32	0.32	0.22	

Tubers which had been sprayed or dusted to inhibit sprouting produced significantly lower yields when they were not treated with ethylene chlorhydrin to induce sprouting before planting. "Sprayed" tubers

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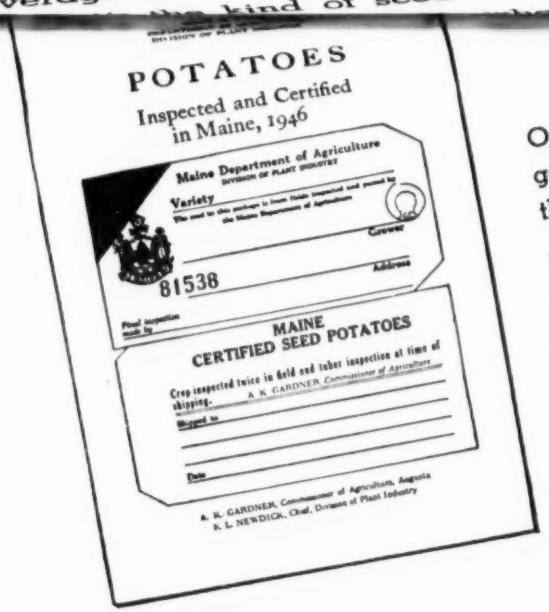

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which were treated to break dormancy yielded almost as much as the untreated checks. The "dusted" tubers, however, which had fewer and smaller sprouts at time of planting did not recover from the sprout inhibiting treatment rapidly enough to overtake the growth of untreated plants even when treated with ethylene chlorhydrin. It is possible that an earlier treatment to break the chemically induced dormancy of such tubers would result in yields equally as high as those untreated tubers.

Summary and Conclusion

(1) Triumph and Cobbler seed potatoes were (a) dusted with the methyl ester of naphthaleneacetic acid at the rate of 20 milligrams per kilogram of potatoes, or (b) sprayed with a commercial preparation containing ethyl naphthl acetate. Lots of each group were stored at two temperatures, 50 - 55° F. and 68 - 82° F.

(2) Just before planting, one-half of the tubers from each of the tubers of the above lots was treated with ethylene chlorhydrin to induce sprouting.

(3) Tubers dusted with methyl naphthaleneacetic acid produced on measurable weight of sprouts in 99 days, whereas tubers which had been sprayed and tubers which were untreated sprouted freely during the same period.

(4) When planted in the field, tubers which had been treated to inhibit sprouting were slow to emerge. Forty-five days after planting the sprouts on only 75 per cent of such seed pieces had emerged from the soil. The plants had a relatively low number of stems per hill and produced a relatively low yield per hill.

(5) Tubers which had previously been treated to inhibit sprouting, when treated with ethylene chlorhydrin just prior to planting sprouted more rapidly than did the comparable untreated tubers. The final stand from tubers treated with ethylene chlorhydrin, was equally as good as was attained from tubers which had not been subjected to any chemical treatments. Treatments with ethylene chlorhydrin also resulted in more stems per hill and increased yields.

(6) Seed tubers which had been chemically treated to inhibit sprouting when treated with ethylene chlorhydrin to induce sprouting did not produce as high yields as did seed tubers handled in the usual manner. However, the data obtained indicate that proper timing of the dormancy-breaking treatment may result in yields equally as good as those obtained from normal seed tubers.

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SECTIONAL NOTES

ALABAMA

Planting of the spring crop of Irish potatoes in the commercial section of Alabama started during the week of January 27. It had been expected that considerable acreage would have been planted before this time but wet weather prevented the preparation of the land. With a few days fair weather planting will be pushed to the limit. It is expected that most of the seed will be in the ground before February 15.

It now seems that there will be about 300 cars of seed planted in the commercial crop. Figuring about 55 acres to the car or about 8 bags of seed to the acre, we can expect the total crop to be near 17,000 acres. There will be better than 80 cars of this seed of the Sebago variety or almost one-third of the total planting. There are indications that some of the growers will plant their Sebago seed first instead of last

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as in previous years. The fertilizer situation is acute but somehow enough will be made available to plant the Irish potato crop even if other crops are shorter later on. The estimated planting of 17,000 acres in the commercial planting of Irish potatoes gives about a 25 per cent reduction in this year's crop. Most of the potato growers will be in a position to meet requirements for the support program.

The quality of the seed has been very good this year so far as size and condition at time or arrival are concerned. Most of this seed was secured from Certified Growers who have sold seed in this area with a reputation of good potatoes. We think that our growers have the "Cream of the Crop" for their seed.

Planting of 170 test samples and some 20,000 index tubers will get under way at the Gulf Coast Substation at Fairhope this week. Another extensice blight experiment will be carried this year together with several tests for observation in different places over the area. (Feb. 3)—FRANK E. GARRETT.

INDIANA

It is apparent that the potato situation is a rather touchy subject at this time and, of course, the disposition of the surplus potatoes and the cost of the government being printed in most of the state and local papers was not the best publicity. Trying to hold the price up and forcing people to eat potatoes is not the way of the American public.

Although we have received no official notice, there is some talk in our state of increasing our acreage approximately 6-10 per cent above last year's crop, in hopes that we can relieve the transportation of potatoes from various other sections into Indiana. We have no complaints to offer with reference to our growers. They are doing a very good job. We are getting some well graded and high quality and also well-packaged potatoes in our stores, and this will mean that it will be harder for other sections to ship into our state unless they meet the same qualifications or have something better. (Jan. 27)—W. B. WARD.

MAINE

The outstanding event at present is the disposal program of the Federal Government in dealing with the big surplus with which we are all faced. About February 1st authorization was given to dispose of eleven million bushels of potatoes in addition to the previous commitments of a rather indefinite amount of several million bushels that had been showing spoilage. This is also in addition to potatoes being ground for a starch and shipments for export.

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This quota of eleven million bushels exceeds slightly the amount offered by growers up to February 1st as an accumulation of their monthly 20 per cent quotas. To those who are "horrified at the waste" involved, it might be well to point out that the waste came in producing this surplus and not so much in disposing of it. It was a waste of manpower, soil resources, seed and fertilizer but no one could foresee that, as the acreage in 1946 was the lowest in more than 25 years.

If manufacturers waste raw material or freeze production the public thinks nothing of it. When farmers attempt to face their problems on just as realistic a basis a great human cry goes up from the public on dumping potatoes and killing little pigs. Farm income must not be allowed to decline so drastically as to produce the chaos we had in the 20's and 30's even if some serious measures have to be adopted. It is the hope of farmers here and elsewhere that stand-by plants can be set up to use this surplus in those years when it is apparent that a surplus exists. That is a better solution.

Potatoes are being exported to Portugal, Spain, Albania, Italy and the UNRRA will also be taking some volume. Markets are showing more activity under the stimulus of the reduction of the overwhelming surplus. It is hoped that sufficient enthusiasm will enter the deal so that the trade will be able to handle potatoes profitably. There has been no speculative interest or enthusiasm whatever thus far and there is considerable evidence to indicate that such a depressed attitude inevitably results in decreased sales and consumption.

Growers in Maine are almost universally ready to cooperate in a program curtailing acreage. Individual allotments are now being set up. The Florida readings on our seed samples this year have been the best that Maine has ever sent. Our seed trade will be getting foundation seed in many cases, and the quality as a rule is better than we have sent out before. This should meet with the favor of our seed customers throughout the eastern half of the United States. Never before has so much good seed been available and we are taking steps to spread this best seed among our own table stock growers in every way possible.

There is much discussion of an increase in the advertising tax. Growers are now paying one cent per barrel on all potatoes shipped and there is much interest in doubling this amount making a total of two cents per barrel. After all this is a pretty small investment in relation to the value of our crop and the need for improving the distribution and consumption of our product. However, steps are being taken to set up a research administration in marketing to comply with the provisions of the Flannigan-Hope Bill. We are jealously watching these funds to

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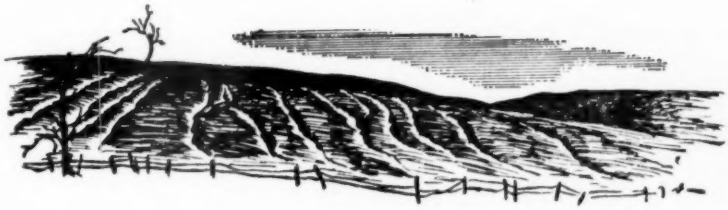

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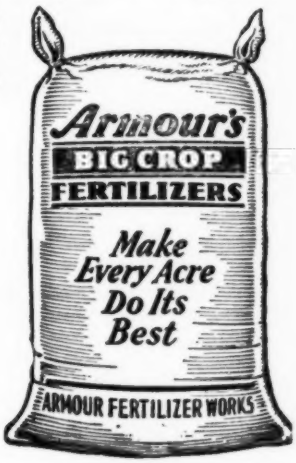

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see that they be kept in marketing only and not diverted under clever guises to additional production experiments. Information in marketing is the great need today. Facts on marketing are limited because of lack of research in the past. (Feb. 7)—FRANK W. HUSSEY.

NEBRASKA

The movement of seed and table potatoes from western Nebraska shipping points has been about normal for the time of the year. The movement, however, is not sufficiently heavy, considering the large crop that was grown, and shippers expect that there will be a hold-over in the spring as a result.

The Government program of disposing of surplus potatoes has been in operation though in a small way to the present time. The actual dumping of potatoes has not gotten under way, although a substantial proportion of our crop is expected to be disposed of in this manner.

Prices for table stock have been about at support, and, occasionally, below support prices. Seed potatoes have sold at a fair margin above support, although many growers feel that the price was not high enough to cover cost of production this season. Costs of production were excessive,—particularly at harvest,—because of very adverse weather conditions, and a prolonged harvest season.

The prospects for planting this coming year are nebulous at this time. Probably some voluntary reduction in acreage should be expected because of the poor prices and difficulty of disposing of this year's crop. Actually, the production goals set up by the AAA are about the same as last year, in view of the fact that Nebraska production has been down for several years. Certified seed production is expected to be curtailed somewhat because of the extremely large crop of last year, and the difficulty of selling this year's crop. The total tonnage of certified seed sold to date actually exceeds that of previous good years, but the very large crop still means that there is a considerable amount in growers' cellars at this writing, though the movement is still fairly active. (Feb. 7)—MARX F. KOEHNKE.

NEW JERSEY

The Thirtieth Annual Meeting of the New Jersey State Potato Association was held Thursday and Friday, the 23rd and 24th of January and was one of the best attended in many years. Three hundred and fifty potato growers and others interested in the potato industry attended the Thursday session, and more than one hundred the Friday morning session. The Potato Association's banquet and dance held

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F. S. Bucher, County Agent, Lancaster County, Pennsylvania, and Jacob K. Mast, owner, with two potato pickers who helped harvest the record crop.

Jacob K. Mast, Caernarvon Township potato grower, is the new "Potato King" of Lancaster County, Pennsylvania with a recorded yield of 734.07 bushels per acre as checked by County Agent F. S. Bucher, who certified its accuracy to State authorities. A veteran potato grower, "Jake" Mast stated to John J. Gross, Summers' representative in Pennsylvania, as follows—"I have used Summers' Potato Fertilizer for the past ten years with excellent results, both with respect to yield and quality. My 1946 record-breaking potato crop was grown with Summers' 4-12-12 at the rate of 1000 pounds per acre applied in bands. With this background of performance, you may count on me continuing to use Summers' Fertilizers."

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Thursday evening was also a great success with approximately two hundred and fifty persons present.

Potato growers are receiving their acreage allotments for 1947 with mixed feelings. Some growers are seeking to have their allotments increased, whereas others are accepting the 20 per cent cut as inevitable and a necessary action if production is to be brought in line with consumption.

This is a year when every grower should plant certified seed only, since so much of it is available at very reasonable prices. No grower should take a chance on selected seed for the sake of saving a few cents, when both certified and foundation seed are so plentiful and can be obtained at so reasonable a price.

Numerous New Jersey growers have started to cut their seed for spring planting and many of them have most of their fertilizer supply on hand. Fertilizer is not very plentiful and growers may find that they will not be able to get the analysis they want when the planting season opens in late March.

Many growers are planning to use benzene hexachloride on a portion of their potato acreage. This insecticide gave outstanding control of wireworms in experiments conducted by the New Jersey Agricultural Experiment Station last year, but it will not be recommended for general use until further experimental work is conducted. Our growers have been cautioned to use the material sparingly and only on a very limited acreage since its use is entirely in the experimental stage. (Feb. 10)—J. C. CAMPBELL.

NEW YORK

The potato business in up-state New York is continuing on an even demoralized keel. Even, because it has been this way all winter and demoralized because there are so many different prices and grades. No. 1 table stock, for instance, may vary 75c cwt. in different localities depending on whether it is utilized locally or shipped out of state. Many growers are under the government plan and are holding for the support price but many others are selling at the market which is approximately $2.10 cwt. figuring that they might better move them now than to wait until spring.

The recent announcement that growers could dispose of their so-called fringe sizes and deteriorating lots at once has tended to put more confidence in the market and the program. But by the time this news note is printed it may be a different story.

Seed potato growers in this area are much concerned about the

CERTIFIED FOR SEED

This 19-minute 16mm sound color film outlines the growing of seed potatoes from planting to shipping. Cutting and disinfection of seed, preparation of soil and use of fertilizers, crop rotation, cultivation, spraying and dusting, digging, storage, grading and packing are treated. Scientific research on potatoes and the work of the seed certification service are emphasized. The film was produced by the National Film Board of Canada for the Department of Trade and Commerce and the Department of Agriculture.

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recent announcement by the government showing a big crop of certified seed potatoes. The statistics were gathered last fall and do not apply to the present situation. Many growers have sold their certified seed because they ran so large it would not pay to grade out the seed size and several lots have been turned down, since last fall because of bin infection and the Florida test. Our growers claim that there will not be enough good seed to meet the demands.

New varieties are in quite some demand. All stocks of the blight immunes, Empire, Placid, Virgil and Essex are covered by orders. At the present time there are a few Eries left. This variety seems to be replacing Katahdin in some sections.

At the recent meeting of the Empire State Potato Club and other sessions at which problems have been discussed there has been a tendency toward a future plan based on marketing agreements with facilities for utilizing low grades. It is felt that support money could better be utilized for facilities than in the way it is being handled. (Feb. 3)—H. J. EVANS.

NORTH CAROLINA

Our commercial early Irish potato growers have indicated that they intend to plant 29,000 acres in 1947 which is 15 per cent less than was harvested in 1946. The report is based on an "intentions to plant" survey conducted by the Federal-State crop-reporting service, and is 18 per cent less than the ten-year (1936-1945) average. (Feb. 5)—M. E. GARDNER.

OHIO

The potato market is very dull. The holding of potatoes is somewhat larger than it was a year ago, but most of the potatoes now available are Russets and the markets do not want this variety. Russets are grown chiefly for the chipping market, but the variety is not chipping white this year.

The potato acreage in Ohio was cut one-half during the war period. The acreage was reduced from around 120,000 acres to nearly 56,000 and Ohio has been given approximately the same acreage that they had a year ago, therefore, there has not been much activity at the present time to reduce acreage further, but I am informed by the AAA office that growers are not coming in to sign up under the support program next year. A letter to the potato growers has informed them about the support program and the necessity for signing up if they desire support in 1947 and 1948. This may stimulate the sign-up. (Feb. 5)—EARL B. TUSSING.

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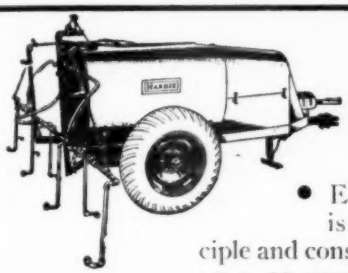

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PENNSYLVANIA

A recent visit to a number of potato storages in the principal seed potato growing region of Pennsylvania revealed some rather encouraging results in regard to the keeping quality of the certified seed crop. Growers are finding the seed crop is storing much better than they had anticipated earlier in the storage period. Even though a few lots of seed show considerable break-down, most of the certified stock is apparently keeping much better, in storage, than was expected.

Our seed growers also report a very light inquiry and poor demand for seed, with prices ranging from $2.90 to $3.25 per cwt. at the growers' cellar.

The Pennsylvania Farm Show was held at Harrisburg during the week, January 13 to 17 inclusive. It was estimated that a total of 540,000 people attended the show during the five-day period. The week was also devoted to Farm organization meetings, which, of course, included the Potato Growers. Their two-day meetings, as well as the commercial machinery displays, attracted a large number of interested potato growers. New developments in potato growing machinery that was of special interest, were the new Oliver TNT plow and the John Bean potato harvester.

The Potato Banquet was attended by more than 400 persons, at which time 83 new growers were presented for membership in the "400 Bushel Club." The highest potato yield reported for 1946 for the state was 782 bushels grown by J. E. Grove & Son of York County. This acreage was measured and one-tenth of the area was dug and weighed from the measured acre. It is believed that this is a record yield for unirrigated ground. The variety grown was the Russet Rural. (Jan. 24)—K. W. LAUER.

RHODE ISLAND

Potato growers are making plans for an exhibit at the Southern New England Farm and Home Show, to be held in Providence from the 25th of February to the 1st of March. Their purpose is to boost Rhode Island grown potatoes. Plans are also under way to form a state-wide organization,—the purpose of which is to help solve the mutual problems of the potato growers. A meeting has been held in each of the potato-producing areas, where considerable interest was shown and committees were appointed.

The task of assigning allotments to the growers has been completed. On the whole, they have been very well accepted. However, there is some feeling among growers that they should not have received

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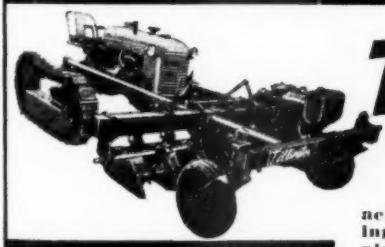

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a 15 per cent cut when the neighboring states of Massachusetts and Connecticut received practically no cut. The feeling seems to be that this is still a deficit state,—producing only about two-thirds of its potato requirements, and therefore it should not be cut as much as some of the surplus states. However, it is anticipated that cooperation will be nearly 100 per cent.

There is still a large surplus of potatoes to be moved. I understand that a number of cars have been loaded recently for overseas shipment. It is hoped that this outlet will continue, as this not only helps move the surplus, but also helps feed some hungry people that really appreciate food.

Reports from dealers indicate that seed and fertilizer orders are far behind normal for this date. However, now that allotments have been made, they expect a rush of orders. (Feb. 5)—AVERY E. RICH.

WASHINGTON

The first results from out-of-door potato test plots have been distributed to the White Rose growers. These results indicate that the growers are making good use of testing to eliminate virus-infected planting stock.

From all indications, compared with last year, there is less than one-half of the disease showing this year. We realize that D.D.T. was quite an important factor in holding the various virus vectors in check and that the combination of thorough roguing, regular dusting and seed selection by plot or greenhouse testing is the answer to many of the seed growers' problems.

These early-tested lots were those that were eligible for foundation stock, but were held up for test plot results. The tests indicated that 57 per cent of these foundation lots showed no disease. One lot showing 1.38 per cent Mosaic was the only lot showing a total disease of more than 1.1 per cent. We feel that this record of low disease readings is excellent and that the present program is accomplishing a great deal to build up the quality of planting stock. Certification officials and growers will be in attendance at the Plot Day held at Oceanside, California, —the week of the 23rd of February. (Jan. 31)—HAROLD S. SCHAAD.

CANADA

The Great Scot potato, which originated in Scotland in 1906, has given good results in British Columbia. It has demonstrated that it is quite resistant to virus diseases, late blight and Rhizoctonia, over a period of six years. It was grown by eight growers in 1946,—scattered

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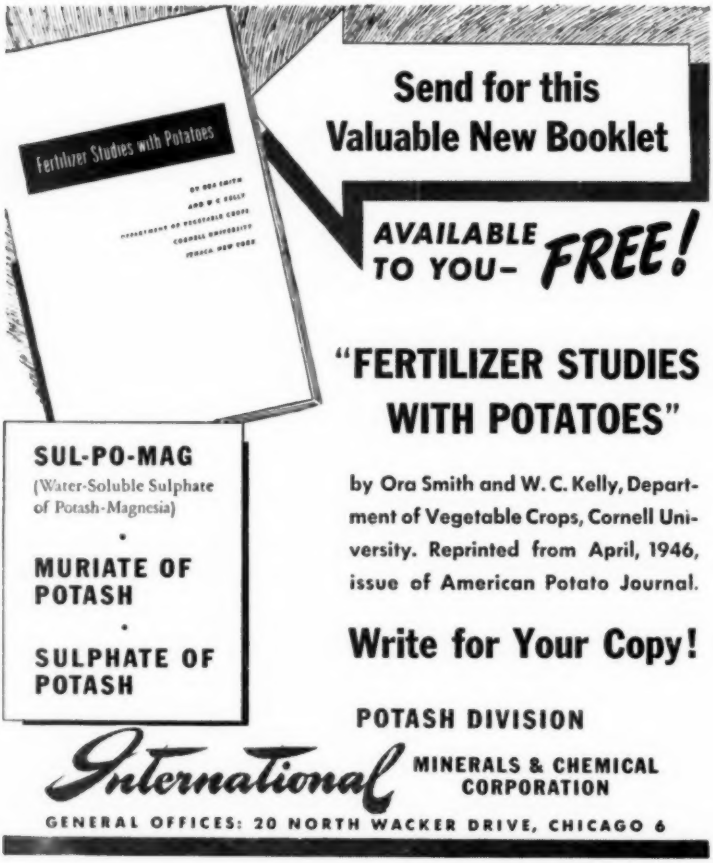
over the province,—and inspected by six different inspectors. All crops inspected, passed as Foundation or Foundation A. grade of seed. It is a second early or early main crop.

The Great Scot variety is immune to wart disease, is a good keeper, of good quality and a heavy yielder. Several reports have been received of yields ranging from 50-1, up to and exceeding 100 to 1 pound planted. (Feb. 7)—E. R. BEWELL.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